by the application of force. Anything that has these qualities is called "matter," hence the definition of matter. Lift the stone. The lifting requires the application of force. Force, a push or a pull. Resistance, a force which acts opposite to the lifting force, the force of gravity in this case. The stone weighs 10 pounds, it is lifted 5 feet against a resistance of 10 pounds. The operation of lifting or of overcoming the resistance through a distance is called work. Work is defined as the exertion of force or the overcoming of resistance through space, and is measured as the product of the force and the distance. The product of 10 pounds and 5 feet is 50 foot-pounds of work. Let the stone fall. Gravity is now the applied force and there is no opposing resistance (neglecting the slight air-resistance) until the stone reaches the earth. It acquires speed during the fall, the speed increasing at the rate of 32.2 feet per second in each second, and when it has fallen 5 feet it has attained a velocity $V = \sqrt{2gh} = 17.9$ ft. per sec.

Thus the student is led forward from the simple concepts which he already has, say at the age of 12 years, as clear as he will ever have them throughout his life, of solid, liquid, gas, distance, force, time, to the meaning of the general term "matter" and to the compound concepts work and velocity, and he is now prepared to go a step further and meet the words, stored work, energy, potential and kinetic, energy of motion, mechanical energy, and to understand the definition: Energy, or stored work, the capacity for performing work.

This definition is pedagogically sound, scientifically accurate as any definition can be, sanctioned by sixty years or more of usage by the best writers, and expressed in language that is probably as clear and satisfactory as any other that can be invented. It fits easily the energy formula $FS = \frac{1}{2}MV^2$, and when heat energy and electrical energy are studied, the doctrine of conservation of energy.

If there is any "existing confusion in the use of the word energy" it is due to modern writers who have departed from the good old definition. When they return to it the confusion will disappear.

WM. KENT

SCIENTIFIC BOOKS

The Vegetation of a Desert Mountain Range. By FORREST SHREVE. Carnegie Inst. Wash. Pub. 217. Washington, 1915. 8vo. 112 pp., 18 figs., 36 pls., 1 chart.

This book is addressed especially to workers in physiological plant ecology, but it should be valuable, also, to students of physiographic ecology and to those whose interest lies primarily in the floristic aspects of vegetations. Furthermore, all who respond to the undefinable call of deserts and mountains will sense the impulse that leads to pack-saddle and sleeping-bag, if they will but glance at the wonderfully good half-tone illustrations here brought forth. It is a little to be regretted that these plates, at the back of a rather special scientific monograph, may not reach nearly all who might derive much pleasure and profit from them. This is a characteristic of good ecological work, that it interests not only the specialist in out-of-door biology, but also nature-lovers in general and non-ecological scientists.

Perhaps the most striking general feature of the monograph lies in the fact that Shreve's presentation of his very thorough knowledge of this mountain range does not stop with pictures and descriptions, nor does it depend, for its scientific interest, upon general theories as to how the various features considered may be related. He goes much farther, and devotes more than half the book to measurements of climatological conditions and actual correlations between these and plant distribution. Realizing the fundamental importance of climatic features in determining plant activities, students of plant distribution have long wished for this sort of treatment, but only a few have thus far found the opportunities, the patience and the insight, to correlate quantitative climatic measurements with ecological observations. This publication will probably have its greatest value to ecological science in the suggestions that it offers as to quantitative methods of attack upon the vegetation-climate correlation.

The Santa Catalina range lies near Tucson, Arizona, and rises from a basal elevation of about 3,000 feet to a height of 9,150 feet, thus

presenting an altitudinal range of over 6,000 feet. The gently-sloping plains or bajadas about this mountain-mass are clothed with a low, open vegetation, in which the creosote bush (*Covillea tridentata*) plays the leading rôle. Passing from the base to the summit of the range the observer meets with a constantly changing panorama of vegetation. Shreve considers three vegetational types in this series, the *desert,* the *encinal* and the *forest.* The first type is similar to that of the bajadas, becoming modified as one ascends, and is considered as ceasing at an altitude of about 4,000 feet on the north slopes and 4,500 feet on the south ones. Encinal is next encountered, extending on the south slopes to about 6,300 feet and on the north slopes to about 5,800 feet. This type is characterized by a spotted and open stand of evergreen oaks (*Quercus oblongifolia* and *Q. arizonica*) in its lower reaches, and by nearly closed stands of these and other small trees in its upper region. Juniper, manzanita, and such plants as *Dasylirion, Nolina, Yucca* and *Agave* occur in this region, and another oak (*Q. emoryi*) and a scrub pine (*Pinus cembroides*) are common in the upper encinal. The upper encinal grades into the lower forest, the latter dominated by Arizona yellow pine (*Pinus arizonica*), which extends to the summit of the range on south slopes and to an altitude of about 7,500 feet on north slopes. On the north slopes of the highest points and ridges an entirely different type of forest is encountered, the white-fir forest, which is dominated by *Pseudotsuga mucronata, Pinus strobiformis* and *Abies concolor* (white-fir), the latter especially in the upper regions. The fir forest is by far the most mesophytic of all the habitats considered.

As to floristics, the flora of the desert and encinal regions is closely related to that of the Mexican deserts lying to the south, while the relationships of the forest flora are partly with the flora of the Mexican Cordillera and partly with that of the Rocky Mountains. "The Mexican group is more conspicuous in the make-up of the vegetation, while the Rocky Mountain contingent is apparently preponderant in number of species" (page 40).

Shreve's discussion of the climatic features of this mountain range constitutes the most important part of the study. The duration of the frostless season here receives adequate attention, for the first time in work of this kind, and the two rainy and two dry periods that characterize the year in southern Arizona are also thoroughly dealt with. A pair of graphs (Fig. 3) with ordinates representing the winter and the summer precipitation as percentages of the annual, plotted to a geographic base (13 stations, from Los Angeles to Mesilla Park, N. M.), have, roughly, the appearance of the letter X. The downward-slanting line refers to winter, and the other to summer rainfall. Los Angeles has high winter precipitation and practically none in summer, while Mesilla Park has much more rain in summer than in winter. The center of the X, where precipitation is about equally divided between winter and summer, lies between Casa Grande and Tucson. Rain-gauges and cylindrical porous-cup atmometers were operated at various different altitudes, for a number of summers, and the results furnish much more satisfactory information than has hitherto been available, on the relation between precipitation and evaporation, on the one hand, and altitude and vegetational character, on the other. Soil moisture, soil temperature and various other climatic conditions also receive attention, and all of these are correlated with altitude, direction of exposure and the character of the vegetation.

Probably the most definite advance in method to be found in this book is the employment of the ratio of evaporation to soil moisture-content, for the period of the arid fore-summer. This ratio exhibits a very satisfactory correlation with the character of the vegetation at different altitudes and on different exposures. Such a novel and very promising method should attract the attention of plant ecologists generally. "The ratio of evaporation to soil moisture comprises a measurement of all the external factors which affect the water relations of plants, except the influence of radiant energy on transpiration and the possible effects of soil temperature on this function" (page 93). For a wealth of in-

teresting and important details regarding these and many other topics, the book itself must be consulted.

Ecologists will find in this monograph many new expressions and many new points of view, of most of which those will approve who have come to think of the plant as a complex of physiological processes, rather than as an intricate object to be described and depicted. The newness of this sort of thinking and the complexity of the relations involved have made necessary the employment of a number of new expressions, which may require modification later, but the author is to be congratulated on his general avoidance of words not readily understood by the average intelligence; especially has he avoided that tendency toward ultra-technical, Greek, classificational terms which so hindered real progress during the earlier years of ecological philosophy. He is also to be congratulated on the unusual clearness with which he approaches the relation of conditional control—the relation of cause and effect, in the common sense. Effects are not here confused with causes and plants are not endowed with judgment.

To find fault is as difficult in this case as it always is distasteful, but if fault must be found let it be with reference to a few poorly chosen words, such as vegetistic (for *vegetational*) and habital (for *with regard to habitat*). The latter seems to the reviewer to be actually ambiguous.

B. E. LIVINGSTON

Laboratory Manual in General Microbiology. By WARD GILTNER. John Wiley & Sons. Pp. 418. $2.50.

It is fitting that a laboratory manual in microbiology should come from the laboratories of Michigan Agricultural College following the appearance from the same place of Marshall's "Microbiology." Like the latter book, this manual of Giltner's covers the whole subject included under the term microbiology, so far as to include the study of bacteria, yeasts and molds. The laboratory methods which are here given have been the result of ten years' accumulation of data in the laboratory at Michigan and have therefore the merit of being thoroughly tested. As a compendium of laboratory methods and as a book of reference the book is very valuable, for there is hardly any phase of the rapidly growing study of these three groups of organisms that is not touched upon. It would hardly be possible to use it as a laboratory course, since it goes over an extent of ground which would be practically impossible to cover in any ordinary course. Indeed, it would be of doubtful wisdom to attempt to have any class of students complete such an extensive series of preliminary laboratory exercises as a preparation for the real work of a bacteriologist.

In attempting to cover the whole of the ground of such an extensive study it is inevitable that some topics should be more satisfactorily treated than others. The whole manual shows evidence that it has been developed in an atmosphere of agricultural rather than medical bacteriology. While serum therapy and pathologic bacteriology are treated the treatment assigned to this phase of the subject is less satisfactory than the rest of the manual. An allotment of 34 pages out of 418 to the whole subject of serums and pathogenic bacteriology is either too much or too little; too much if the book is designed for agricultural and general students only, and too little if aimed at medical students.

Naturally slight omissions are found here and there which are open to criticism. To recommend in making culture media the use of Witte's peptone *only*, at this time when Witte's is not to be obtained and when American peptones are proving perfectly satisfactory, is surely open to criticism. To omit absolutely any reference to the preparation and use of Endo medium is hardly defensible, considering the extended and growing use of this medium, and to describe the Gram method of staining without even a reference to the need of counter stain after decolorizing can hardly be excused. But slips of this kind can not be avoided in a book with such a wide scope as this, and the manual is surely to be commended as one of great value in any bacteriological laboratory.

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